



INDIAN OCEAN
COMMISSION



CORAL BLEACHING MONITORING GUIDE WESTERN INDIAN OCEAN - 2016

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For updates on these methods, resources associated with them (e.g. bleaching photo guides) and training materials/webinars, go to www.reefresilience.org (Western Indian Ocean group) and www.cordioea.net/WIO-bleaching

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Table of contents

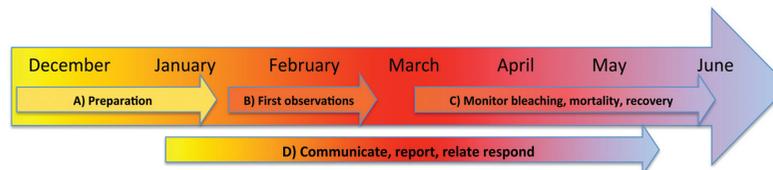
INTRODUCTION	4
Setting up a bleaching response plan.....	4
Which level of monitoring is best for you?.....	5
Photographic techniques/backup	6
METHODS	7
Basic – broad estimate of bleaching & mortality.....	7
Intermediate – bleaching & mortality prevalence by coral colonies	8
High – bleaching & mortality by unit area and coral biomass (area)	10
DATA ANALYSIS AND MANAGEMENT	12
EXISTING METHODS	12
Nature Seychelles – basic and intermediate.....	12
Timed swims = basic.....	12
Point-intercept transect = intermediate	13
Temperature	14
Notes	14
Wildlife Conservation Society - intermediate.....	14
Estimated area-sampling = intermediate	14
Further analysis.....	14
Notes	15
CORDIO/IUCN resilience assessment & bleaching observations – high	15
Notes	15
REFERENCES	16

Introduction

This is produced as a quick guide to bleaching observation methods for the Western Indian Ocean bleaching season of January-May 2016. References are provided at the end, but a primary reference is Oliver et al. (2004), the bleaching monitoring guide prepared in that year.

Setting up a bleaching response plan

This document describes in detail the methods that can be applied – the overall framework for a bleaching response is provided in an accompanying powerpoint presentation "*WIO bleaching response 2016*".



These methods are to be applied in part C) of that guide "Monitoring", following the flow chart below. The precise timing for application of stages B) and C) differs, with earlier start in the south (south Madagascar, South Africa - February) and later start in the north (Kenya, N. Seychelles - April).

Component	Description
A) Preparation	<ul style="list-style-type: none"> Prepare the overall bleaching response plan and how a program will move from stages A through D during the bleaching event Select methods to be applied in B) and C) Identify the personnel, resources and training needed to apply these.
B) First Observations	<ul style="list-style-type: none"> Prepare the 'first responders', to be alert for bleaching Disseminate descriptions of coral bleaching and a bleaching reference card (xxx)
C) Monitoring bleaching, mortality & recovery	<ul style="list-style-type: none"> Prepare the monitoring teams and observers for their appropriate level of monitoring Identify and assure resources needed for observers to operate – equipment (transect lines, UW camera), transport to the field, if any finance is needed. Train all potential observers so they are capable in the method selected, and consistent among one another.

D) Communication & reporting	<ul style="list-style-type: none"> • Identify the primary stakeholders that need to hear about the progress of bleaching event – managers, resource users, media, the public, etc. • Identify methods for reporting to them when the bleaching response plan moves from one stage to the next • Identify methods for reporting to them the results of each the response plan at three key times – start of the bleaching event (move from B to C), the peak of the bleaching event, and after full mortality levels have been realized. • Prepare a final event report/dissemination
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Which level of monitoring is best for you?

Three levels of monitoring are described, which will provide different levels of information, to suit different levels of need.

Level	Description	Questions addressed
Basic	The most basic level, requiring minimal equipment, preparation, time and expertise. Ideal for programmes based purely on volunteer effort and on resource users/staff with minimal time to spare.	<ul style="list-style-type: none"> • What is the overall level of bleaching and mortality experienced in my area? • Which reefs/sites have been most impacted by bleaching in my area?
Intermediate	This level provides a quantitative estimate of bleaching and mortality affecting different coral genera, based on prevalence (proportion of colonies affected).	<ul style="list-style-type: none"> • The above, plus • What is the degree of bleaching and mortality experienced by coral genera and sites in my area? • How were different coral genera affected by the bleaching event, by number of colonies?
High	This level provides a quantitative estimate of bleaching and mortality in relation to the density of colonies and biomass (area) and age/size-classes of coral genera.	<ul style="list-style-type: none"> • The above, plus • What were the density- or area-dependent impacts of the bleaching event? • How were different size/age classes of coral genera affected by the bleaching event. • How might the reproductive output of the coral community be affected by the bleaching event?

Photographic techniques/backup

Due to the difficulty of identifying corals from other taxa, for inexperienced observers, and of identifying genera even for experienced observers, photographic techniques can be used to collect data, and/or backup in situ observations. These are useful for Basic and Intermediate levels, but the disadvantages of photos for finding, identifying and measuring small corals means they are not useful as backup for advanced techniques.

To use photographic techniques, the following basic equipment and capability is needed:

- An underwater camera/video that can take high quality still images – most current digital cameras can be used, and GoPros have adequate resolution for still photos.
- Always use a 1m monopod/spacer stick to assure consistency with other programmes, of a 1m camera-to-benthos distance.
- Where possible, reset the white balance for the depth of the photographs, or an underwater setting – the enhanced red makes a massive difference in being able to differentiate corals from other benthic invertebrates and algae, and to identify genera.
- You will need to select and label the images clearly, and store them on a computer hard drive in one folder per site per sampling event.
- Ideally, you should then need to be able to upload these images to a photo-sharing site (details to be provided), so that they can be viewed in real time by observers with more experience.

Methods

Basic – broad estimate of bleaching & mortality

Component	Basic
Sampling location	<ul style="list-style-type: none">Arbitrary, use 5-6 minute time swim for standardization
Spatial	<ul style="list-style-type: none">Broad area of reef in view, perhaps 10-50 m along
Corals	<ul style="list-style-type: none">All hard corals, key genera noted where possible.
Bleaching & mortality observations	<ul style="list-style-type: none">None (<1%), low (1-10%), medium (10-50%), high (50-90%), extreme (>90%) bleaching.Can also use the same levels to estimate mortality.
Method – in situ	<ul style="list-style-type: none">Estimate overall “look” of coral community, for all corals combined, and estimate proportion in categories given above.Can do an overall count of colonies affected or not, to help estimation of %, but be aware of tendency to focus on larger colonies.Note key features, such as principal genera affected, and estimate proportion for those, if possible
Method - photographic	<ul style="list-style-type: none">Take 2-3 general views of the reef area, plus 10 or more vertical images 1m above substrate, separated by 2 or more meters.Two methods for analysis:proportion of corals is estimated as a % of coral community in each category in each photo, averaged across the photos.using 5*5 grid of points (25 per frame), score number of corals in each category, add together for total, and calculate % per category.Use a 1m long PVC stick/ monopod to help with camera-benthos distance, but try and keep it out of the frame to maximize the utility of photos for other purposes.



Pros	<ul style="list-style-type: none">• Most accessible for users with low technical skills.• Most rapid, can be applied over many sample sites in a short time.
Cons	<ul style="list-style-type: none">• Very open to personal bias in estimation of area affected and estimating impact.• Minimum taxonomic resolution
Modifications	<ul style="list-style-type: none">• Can add detail on taxonomy (genera) and the proportion affected.• Photos/video can be collected to verify estimates, or for experienced observers to assess basic bleaching levels remotely.
Ideal target population	<ul style="list-style-type: none">• People 'on the job' (dive-masters, snorkel guides, MPA rangers/staff doing routine patrols), volunteers with limited experience.
What do you get?	<ul style="list-style-type: none">• Basic data on overall extent of bleaching, proportion of coral area affected.
Who is doing this?	<ul style="list-style-type: none">• Nature Seychelles – timed swims

Intermediate – bleaching & mortality prevalence by coral colonies

Component	Medium
Sampling location	<ul style="list-style-type: none">• Arbitrary
Spatial	<ul style="list-style-type: none">• Multiple areas selected by eye.• Sizes of 1-2 up to 12 m² in size have been used (2m radius of WCS method gives area of $\approx 12\text{m}^2$).
Corals	<ul style="list-style-type: none">• All coral genera, no size

Bleaching & mortality observations	<ul style="list-style-type: none"> • Fixed classes, e.g. normal, pale, part-bleached (10-50%), bleached (100%), part-dead, fully dead (recent mortality only). • More detailed categories have also been used: 0%, pale (any amount), <20%, 20-50%, 50-80%, 80-100% bleached, recently dead.
Method – in situ	<ul style="list-style-type: none"> • Score ALL coral colonies >10 cm diameter in the sampling area, recording their genus and condition. Take care to not exclude normal colonies. • If uncertain of genus ID, record ('other')
Method - photographic	<ul style="list-style-type: none"> • Take 4-5 general views of the reef area. • Take 20 or more vertical images 1m above substrate, separated by 2 or more meters – follow same guidelines as for basic method. • Analysis same as in basic category, including genus identification and greater replication.
Pros	<ul style="list-style-type: none"> • Relatively rapid, allows for sample selection over wide area of reef. • Can be undertaken more easily while doing other work.
Cons	<ul style="list-style-type: none"> • Bias due to selection of sample points • Bias due to preferential recording of bleaching bleached corals over normal ones, particularly for smaller colonies • Inadequate sampling of all corals - reefs can have >40 colonies/m², so counting all colonies reliably in larger samples (e.g. 2m radius) is unreliable and unlikely to be done consistently. • Fixed classes for pale, bleaching and partial mortality ignore complex interactions between classes, especially partial mortality with partial bleaching.
Modifications	<ul style="list-style-type: none"> • Disease and other conditions can be added. • Use radial lines/quadrats to standardize sampling of unit areas.
Ideal target population	<ul style="list-style-type: none"> • Management and monitoring programmes with semi-experienced staff/students/etc, but contributors are of varying experience levels
What do you get?	<ul style="list-style-type: none"> • Proportional incidence (prevalence) of bleaching & mortality by number of colonies.
Who is doing this?	<ul style="list-style-type: none"> • Wildlife Conservation Society and varied collaborators around the WIO • Blue Ventures (Andavadoaka, Madagascar)

High – bleaching & mortality by unit area and coral biomass (area)

Component	High
Sampling location	<ul style="list-style-type: none"> Arbitrary or fixed.
Spatial	<ul style="list-style-type: none"> Belt transects (e.g. 25*1 m) Due to the higher accuracy of this method, for repeated sampling it is advisable to fix a transect during the first sample(s), using nails at the beginning and intermediate points (e.g. 5 m apart) in the transect. Ideally, record 2 or more transects per site.
Corals	<ul style="list-style-type: none"> Genus, with or without size
Bleaching & mortality observations	<ul style="list-style-type: none"> Continuous scale - proportion (%) of colony pale, bleached, dead. Include disease and other conditions.
Method – in situ	<ul style="list-style-type: none"> Score ALL coral colonies >10 cm diameter whose centers are within the quadrats/belts. Record their genus and % of each condition on the coral colony. If included, record size – the IUCN method uses size classes of 11-20; 21-40; 41-80; 81-160; 161-320; and > 320 cm. If uncertain of genus ID, record ('other') If using fixed transects, only need to record all colonies on the first sample. After that, only record those colonies that show some degree of bleaching/mortality (and disease).
Method - photographic	<ul style="list-style-type: none"> Take 4-5 general shots of the reef area, Take vertical images 1m above substrate along the full line of the transect. Make sure the images overlap enough to show the continuity of the transect. This is unlikely to record the full 1m width of the transect, but the degree of sampling should be comparable (e.g. of a 25*0.6 m belt). Analysis same as in medium category, with greater replication. If sizes are to be included, must use a length scale. This can be a right-angle at the benthic end of the 1m spacer/mono-pod. Use a 20 cm length, marked clearly at 10 and 20 cm.

Pros	<ul style="list-style-type: none"> • Most unbiased method to prevent over-counting of bleached and large corals (forces counting of normal and small corals) • Bleaching and mortality estimates are standardized to coral biomass (area) and density of corals on the reef. • Accommodates variation in bleaching and mortality state of corals. • Addresses size-dependent variation in bleaching
Cons	<ul style="list-style-type: none"> • Time consuming. • Sampling constrained to smaller areas of a reef due to the higher detail, so risk of bias due to spot-selection. • Likely to be too detailed for most management applications, most applicable to research programmes.
Modifications	<ul style="list-style-type: none"> • Multiple additions can be done – e.g. of disease, benthic cover, algae characteristics, etc. to extend the detail of sampling.
Ideal target population	<ul style="list-style-type: none"> • Research programmes and/or well-established management and monitoring programmes with dedicated/fixed staff and the ability to analyse the detailed information and/or use it in management decisions.
What do you get?	<ul style="list-style-type: none"> • Area-based density and general level/detailed relationships among bleaching, mortality & size, and disease conditions.
Who is doing this?	<ul style="list-style-type: none"> • CORDIO, programmes implementing IUCN Resilience method

Data analysis and management

Guidance on data analysis and management is being provided separately, go to www.cordioea.net/WIO-bleaching for details. User-friendly worksheets and methods for uploading bleaching data to a common resource are being provided, and these will be mirrored to the global bleaching repository provided by NOAA's Coral Reef Watch programme at http://coralreefwatch.noaa.gov/satellite/research/coral_bleaching_report.php.

Existing methods being applied in the WIO

Nature Seychelles – basic and intermediate

November 2015, Phanor Montoya-Maya phanor@natureseychelles.org

Two scales of surveys are done - modified timed swims (large scale) and PIT (fine scale), derived from Oliver et al. (2004). Initial surveys are done using the time swims. If moderate bleaching (10-50%) is recorded, then, PIT are used. Temperature is also recorded, using two methods.

Timed swims = basic

Two SCUBA divers visit two long-term monitoring sites. Each diver conducts 5 to 6 two-minute timed swims at each site. Each diver estimates a percentage of bleaching as described in Table 8 in Oliver et al. 2004 (Table below).

Table - Site bleaching levels

Index	%	Description	Visual Assessment
0	< 1	No Bleaching	No bleaching observed, or only very occasional, scattered bleached colonies (one or two per dive)
1	1-10	Low or Mild Bleaching	Bleached colonies seen occasionally and are conspicuous, but vast majority of colonies not bleached
2	10-50	Moderate bleaching	Bleached colonies frequent but less than half of all colonies
3	50-90	High Bleaching	Bleaching very frequent and conspicuous, most corals bleached all colonies
4	>90	Extreme Bleaching	Bleaching dominates the landscape, unbleached colonies not common. The whole reef looks white

Due to local characteristics, two depths are surveyed (6-7 m and 11-12 m), and timed swims are repeated every two weeks

Point-intercept transect = intermediate

10-m transects are used with point intercept distance of 10 cm, giving 100 points per transect. When the point is over a hard coral it is identified to genus and bleaching is recorded as in Table 9 in Oliver et al. (2004), below.

Table - Colony bleaching levels

Category	Description
0	No bleaching evident
1	Partially bleached (surface/tips); or pale but not white
2	White
3	Bleached + partly dead
4	Recently dead

Three transects are done at each depth, giving six per site. These are repeated once a week.

Temperature

One each dive, temperature is recorded from a dive computer.

Every month data is downloaded from temperature loggers at each site and depth.

Notes

The timed swim approach is used as the standard for recommendations here.

The PIT method is not advocated for broader use, as using a transect line with fixed points reduces sampling of coral colonies to a minimal number, especially if they are at low densities.

Wildlife Conservation Society - intermediate

These methods are first described in McClanahan et al. (2007 a & b). Blue Ventures is applying this method.

Estimated area-sampling

Observers moved in haphazard directions and distances and periodically or haphazardly select areas for sampling. A 2 m radius area is selected, giving an approximate area of 12m². All coral colonies are identified to the genus, counted, and assigned into 7 categories of bleaching intensity: c1 = normal and c2 = pale live coral, c3 = 0–20%, c4 = 20–50%, c5 = 50–80%, c6 = 80–100% of the live coral surface area fully bleached, and c7 = recently dead

Sampling is repeated many times for ~40 minutes.

The WCS method further advocates calculating a site index for bleaching and mortality, described in McClanahan et al. (2007).

Notes

This is the most widespread and published method so far used, with data compiled and reported by Dr. McClanahan in several publications. Use of the BR index is not encouraged for basic reporting though, as the weighting applied to each category has not been assessed independently, and combining both bleaching and mortality into the same index goes against most findings that bleaching and mortality are separate processes, including by McClanahan (2004).

CORDIO/IUCN resilience assessment & bleaching observations – high

This method is derived from the IUCN CCCR Resilience assessment method in Obura & Grimsditch (2009).

The basic unit is a belt transect 25 m long and 1 m wide, but this can be shortened based on the complexity of the community and the time it takes to sample. Lay a tape measure to the set distance, for repeated samples, using nails or clear features at 5-10 m spacing to fix the transect line in place. Use a hand-held 1m PVC stick to ensure accurate estimation of the 1m width.

Only colonies >10 cm diameter whose center lies WITHIN the transect are counted – large colonies with their center outside the transect, and colonies < 10 cm, are ignored. All genera should be recorded, for those that cannot be identified, record 'other'. Condition is recorded as the percent of each colony that is pale, bleached or dead, allowing for all combinations of partial bleaching and mortality. Diseases can also be recorded in the same way, or as present/absent by colony.

Size can be recorded at either direct estimates (in cm), or in classes, to facilitate sampling. The IUCN method uses doubling size classes (cm diameters): 11-20; 21-40; 41-80; 81-160; 161-320; and > 320 cm. The 1m PVC stick with marks at 10, 20, 40 and 80 cm can be used to help size estimation.

Notes

The transect-based approach, though time-consuming, minimizes bias by the observer that tends to ignore smaller and non-bleached colonies (we tend to record what we are looking for). This forces a greater focus on the detail of the area of sampling, rather than an overview of a site, which may not serve broader management interests.

Further, the IUCN method selected about 20-25 genera as a focus for assessment, as the additional 30-40 genera found at

WIO sites are hard to identify, small, and/or non-descript. These genera are generally ignored/passed over in sampling that has a broader focus.

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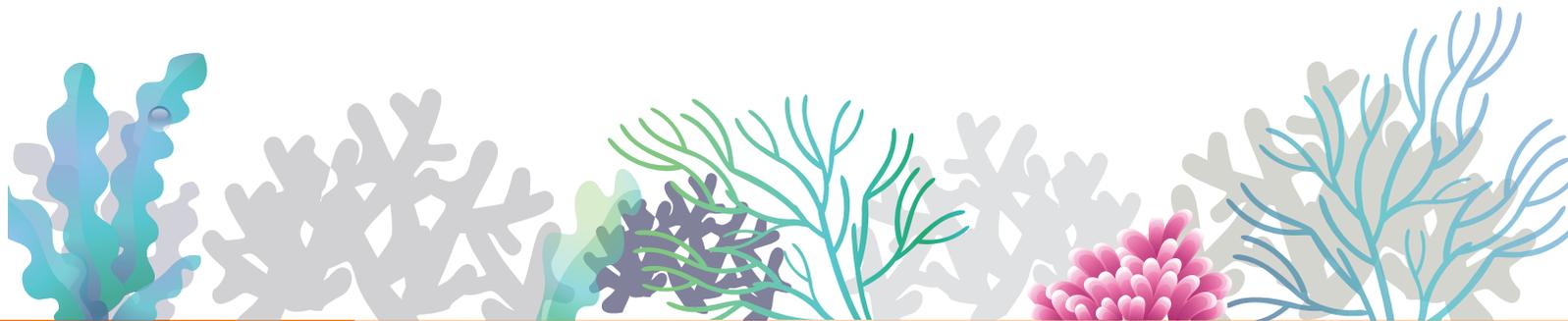
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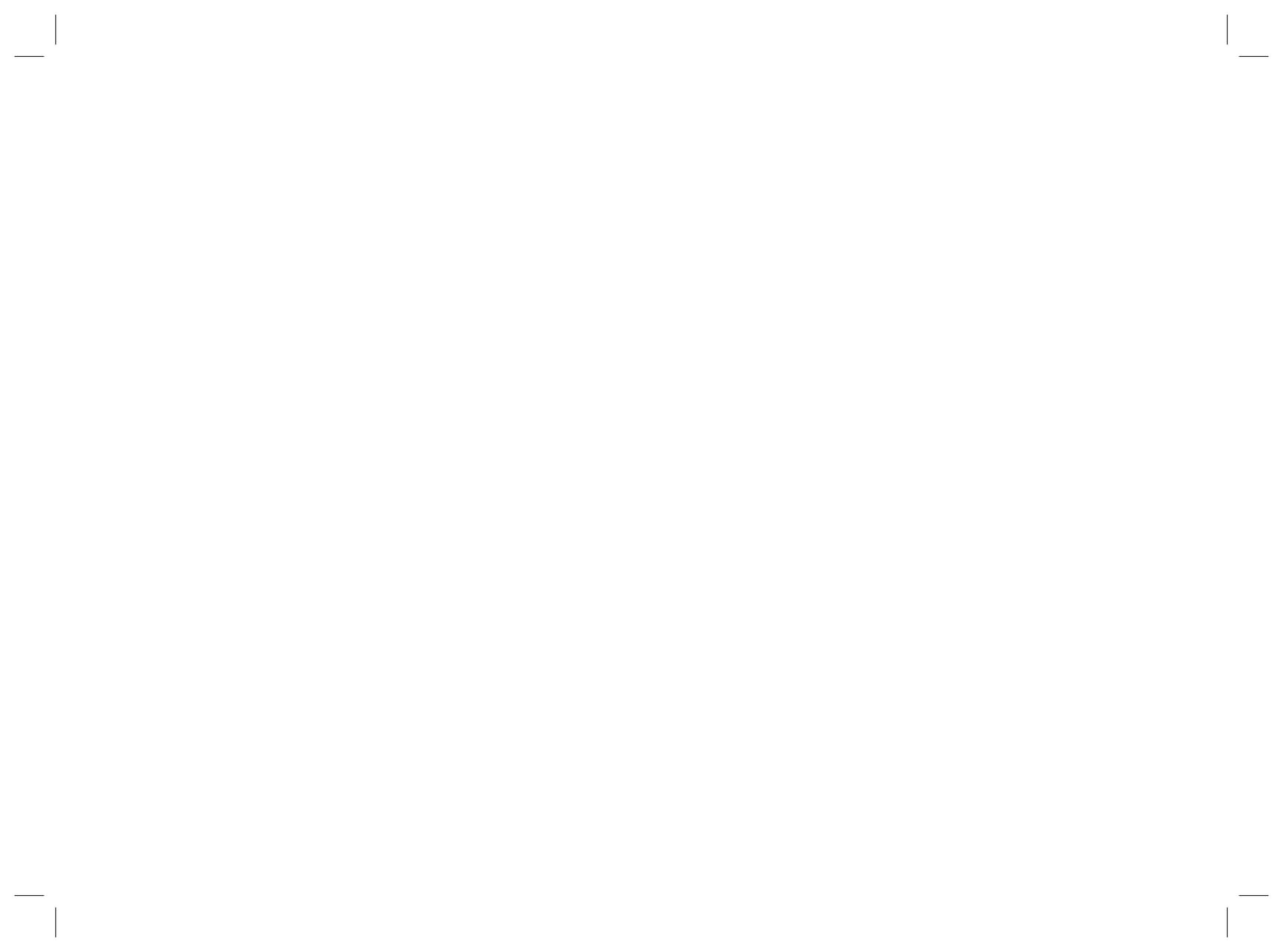
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